SEISMIC SURVEY

PARK RIVER AUXILIARY CONDUIT

HARTFORD, CONNECTICUT

for

DEPARTMENT OF THE ARMY

NEW ENGLAND DIVISION, CORPS OF ENGINEERS

WESTON GEOPHYSICAL ENGINEERS, INC.

WESTON GEOPHYSICAL ENGINEERS, INC.
Post Office Box 550 • Westboro, Massachusetts 01581 • (617) 366-9191

February 12, 1976

Department of the Army
New England Division
Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

Gentlemen:

The seismic survey covered by this report was conducted under the terms of Contract Number DACW 33-66-C-0033. Field work was performed during the period of November 18, to December 3, 1975, and on December 10, 1975.

Preliminary data have been submitted. This report is a complete, formal presentation of our findings.

Very truly yours,

WESTON GEOPHYSICAL ENGINEERS, INC.

for Vincent J. Murphy

VJM:mw

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SEISMIC SURVEY

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HARTFORD, CONNECTICUT

INTRODUCTION

The seismic survey covered by this report took place along the alignment (January 1976 position) of the proposed Park River Auxiliary Conduit in Hartford, Connecticut. Field work took place during the period of November 18, to December 3, 1975, and on December 10, 1975. Previous seismic investigations in the Park River Conduit project area were the subject of our earlier report, dated February 12, 1974.

The auxiliary conduit is one feature of the Park River Conduit project of the Department of the Army, New England Division, Corps of Engineers; the overall project plan is shown on the plan map, Sheet 1.

A new alignment (the January 1976 position) for the auxiliary conduit in the vicinity of Louis Street has been selected by the Army Corps of Engineers, as shown on Sheet 2. The seismic survey investigation took place both along and in the vicinity of the auxiliary conduit alignment. The survey was conducted under the direction of the United

States Army, Corps of Engineers' geologist, Mr. E. Blackey; Weston Geophysical Engineers' project geophysicist and assistant project geophysicist are Mr. V. J. Murphy and Mr. E. N. Levine, respectively.

The seismic refraction survey method used in this investigation is described in Appendix A.

PURPOSE

The purpose of the seismic survey was to determine depths to rock and general overburden conditions, as could be evaluated within the limitations of the seismic survey method. It should be noted that fill materials, interfering noise, and other adverse conditions exist throughout much of this project locale. Also, the preferred seismic energy source, explosives, could not be used (except adjacent to the Connecticut River). This limitation, therefore, required the use of an alternate seismic energy source, a weight drop, provided by a United States Corps of Engineers' drilling crew.

The total coverage of this survey is of a limited nature to the extent that it should be considered only as a reconnaissance exploration program. The results should be used as a guide for establishing detailed drilling programs and for general assessment of subsurface conditions.

RESULTS

General Discussion

The results of this seismic survey are presented on Sheet 3, in the form of a composite profile along the alignment of the auxiliary conduit. Due to the congested nature of the area, many of the seismic lines could not be located along the specific conduit centerline, but were located adjacent to the centerline, and/or crossed the centerline. Measured seismic velocity values of the various layers and the elevation of the seismic discontinuities are shown on the composite profile. Also shown on the profile are generalized logs of the test borings that were performed along or in the vicinity of the auxiliary conduit.

The locations of the specific seismic lines of investigation, which the composite profile was based on, are shown on Sheets 4 through 9. The profiles for these individual seismic lines are shown on Sheets 10 and 11.

Material Identifications and Velocity Values

The identification of the various materials corresponding to the measured seismic velocities was obtained from the test borings drilled at the site. The following generalized geologic correlations with seismic velocity ranges are applicable.

The velocity range of 1,200-2,000 ft./sec. is indicative of loose, unconsolidated, and unsaturated materials. These materials are usually water-lain deposits but may include some fill materials.

The velocity range of 2,500-3,000 ft./sec. is indicative of moderately dense but unsaturated overburden materials, probably an unconsolidated ground moraine-type of glacial till.

A slightly higher velocity range of 3,600-4,400 ft./sec. is indicative of a fine sand, silt, or clay that is not totally water saturated.

The overburden velocity value of 5,000 ft./sec. is usually indicative of saturated clays, and possibly fine sands or silts in this geologic locale.

Seismic velocities of 11,000-13,000 ft./sec. are indicative of bedrock that will require blasting for excavation. The top of the high-velocity bedrock, as shown on the seismic profile, corresponds to the core recovery values of approximately 100% encountered in the test borings. Some weathered bedrock may exist above the high-velocity bedrock in some areas of this project, and not be detected by a seismic survey. For example, Boring FD-3T had an average core recovery of approximately 40% from a depth of 52 1/2 to

64 feet; however, seismic Line 13, in approximately the same general area, indicated that rock with a velocity of 11,000 ft./sec. occurs at a depth of approximately 67 feet. The section of Boring FD-3T with the 40% recovery has a seismic velocity that is probably somewhat less than 11,000 ft./sec.

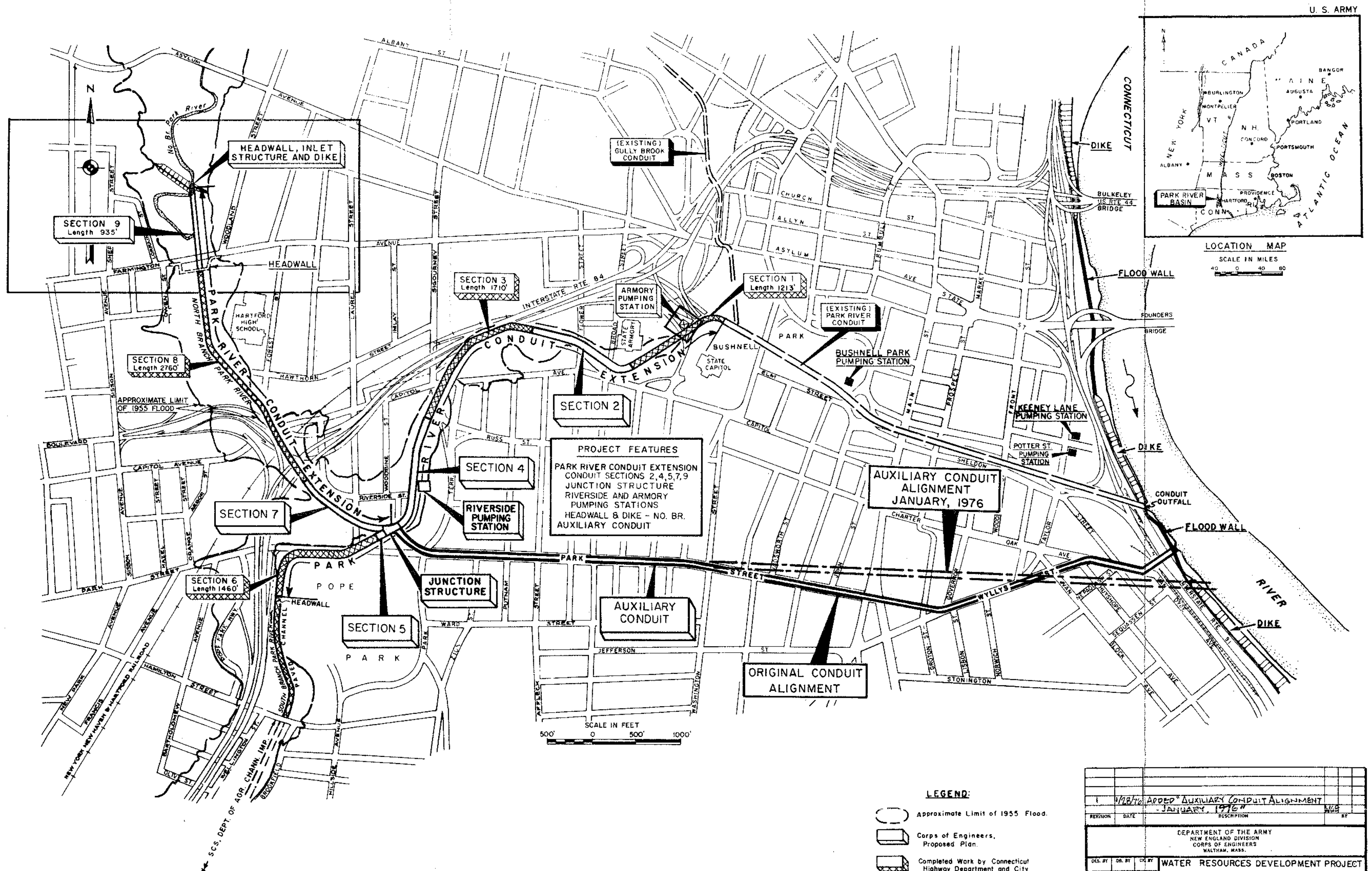
It should also be noted that the bedrock velocities from Stations 6+90 to 19+50 (the eastern portion of the alignment) are generally in the order of 11,000 ft./sec; while the seismic velocities for the bedrock west of Stations 19+50 to 40+92 are generally in the order of 12,500 ft./sec. These velocity differences may be indicative of a slight change in the actual condition of the bedrock, such as the amount of jointing or fracturing, and/or changes in lithology.

RECOMMENDATIONS

Since the data of this survey along the tunnel alignment have been evaluated with minimal drilling control, the following positions are suggested for correlation drill holes: Stations 23+00, 19+50, 17+50, 15+50, 13+50, 11+40, and 9+30.

Drilling at these locations would also allow direct examination of overburden materials and evaluation of the topmost section of bedrock. With regard to this latter point, it should be observed that the measured bedrock velocities are high values, which are indicative of hard, relatively unweathered rock; however, a thin top section or thin zones of rock that are soft or weathered could only be detected by such drilling or by actual excavation.

The logs of these (or other) holes should be forwarded to Weston Geophysical Engineers, Inc. for correlation, review, and adjustment of the seismic profile sections as becomes necessary.



LEGEND:

- Approximate Limit of 1955 Flood.
- Corps of Engineers, Proposed Plan.
- Completed Work by Connecticut Highway Department and City of Hartford.
- Existing Pumping Stations.
- Proposed Pumping Station
- To Be Completed
- Proposed Modifications (All Other Work Same As Authorized Plan)

REVISION	DATE	DESCRIPTION	BY
1	4/28/76	ADDED "AUXILIARY CONDUIT ALIGNMENT - JANUARY, 1976"	NWS

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

WATER RESOURCES DEVELOPMENT PROJECT
PARK RIVER LOCAL PROTECTION
MODIFIED PLAN
HARTFORD CONNECTICUT

PLATE 2-2

SEISMIC SURVEY

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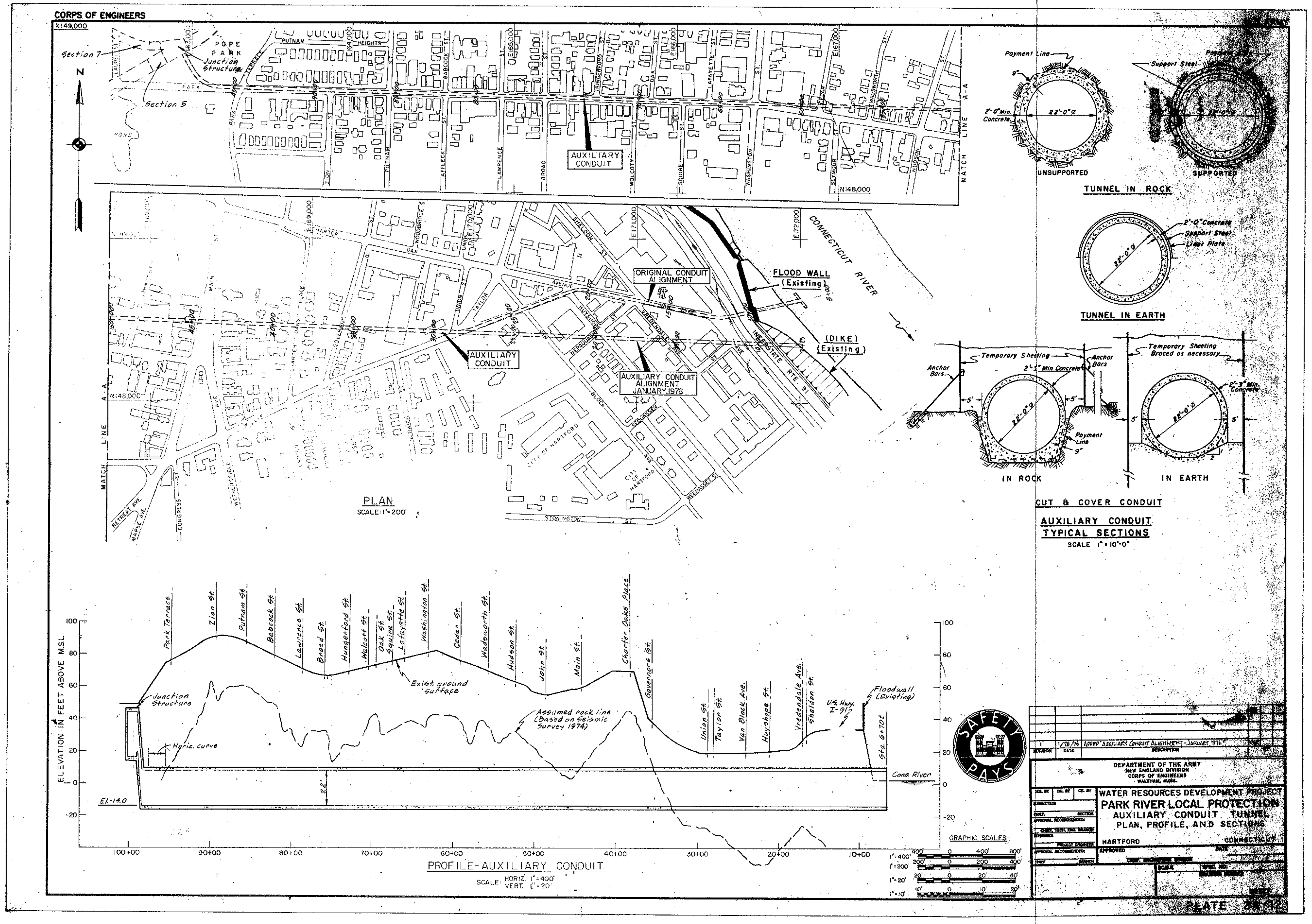
SHEET 1 OF 11



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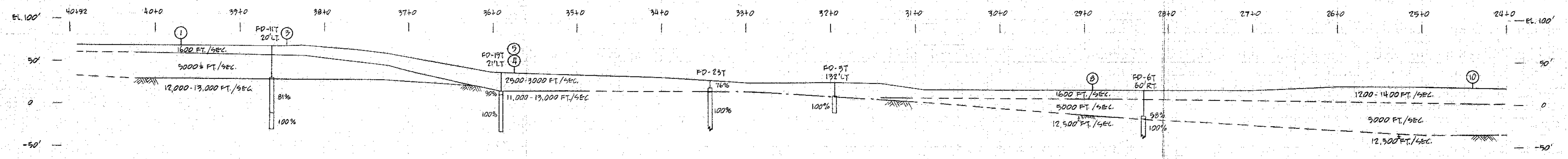
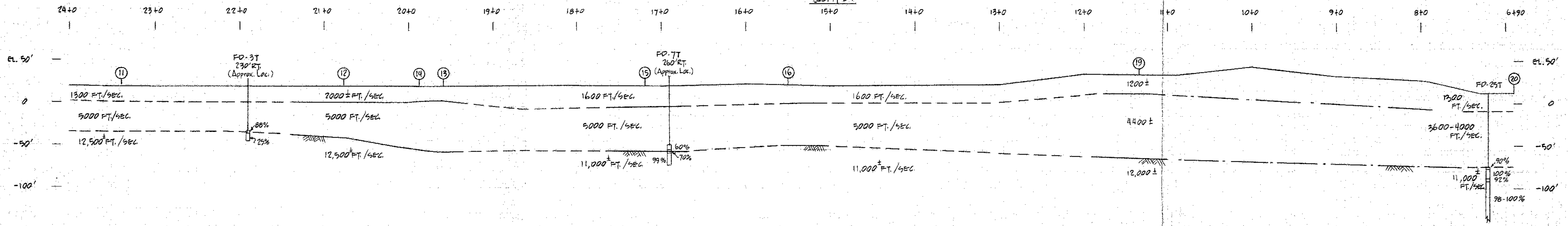
SHEET 2 OF 11

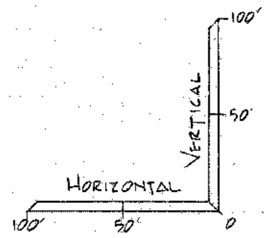
℄ Profile Auxiliary Conduit



℄ Profile Auxiliary Conduit (Cont'd)



Note: This subsurface profile of the auxiliary conduit is a composite section based on data from sheets 10 & 11 (seismic lines 1 through 20) and boring data as shown.



19 = Location of intersection of seismic crossline along ℄ of tunnel

= Profile based on seismic data within 20' of ℄

= Profile based on seismic data greater than 20' from ℄

= Profile interpolated from seismic & test boring data over relatively great distances.

℄ Profile Auxiliary Conduit

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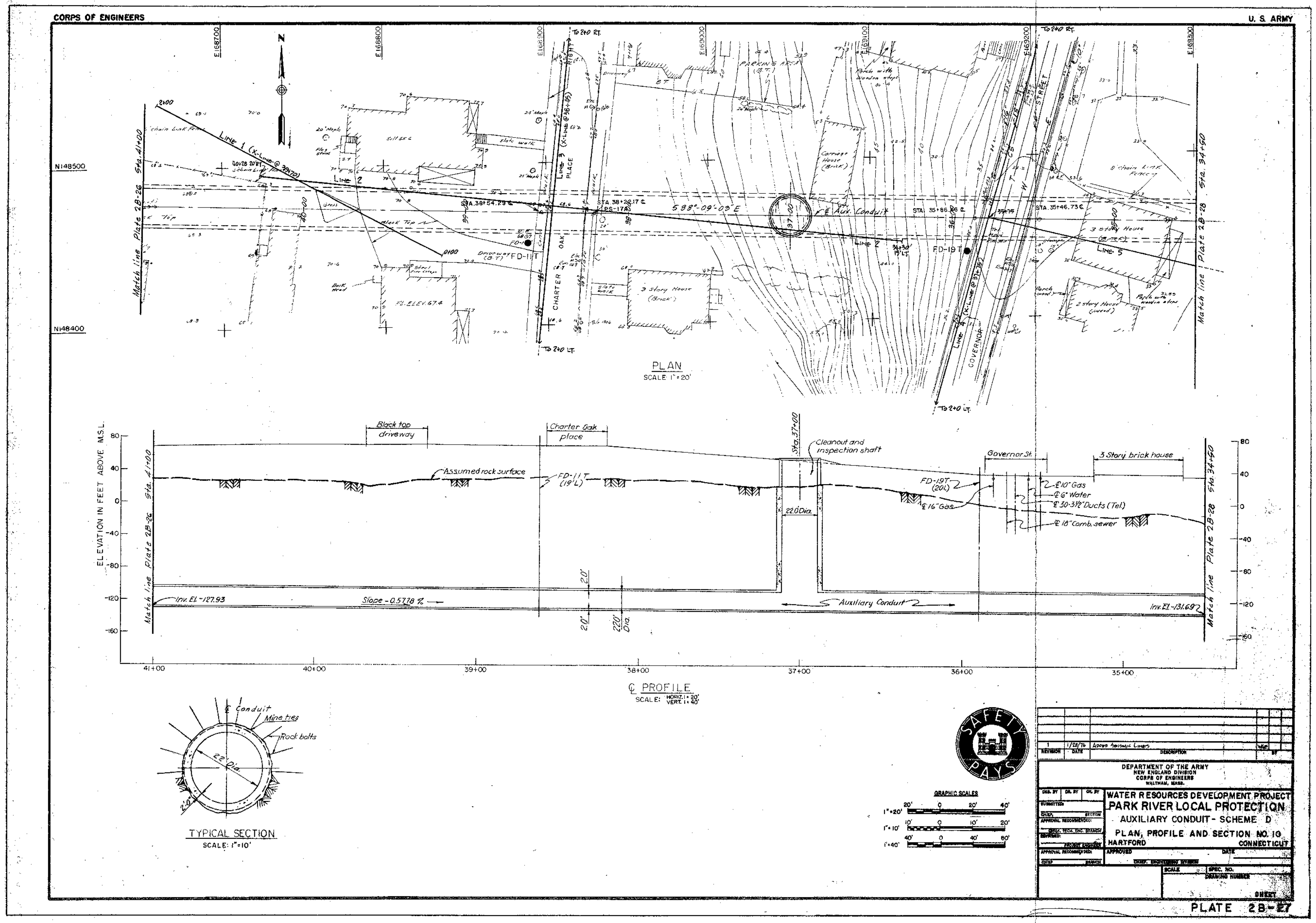
SHEET 3 OF 11



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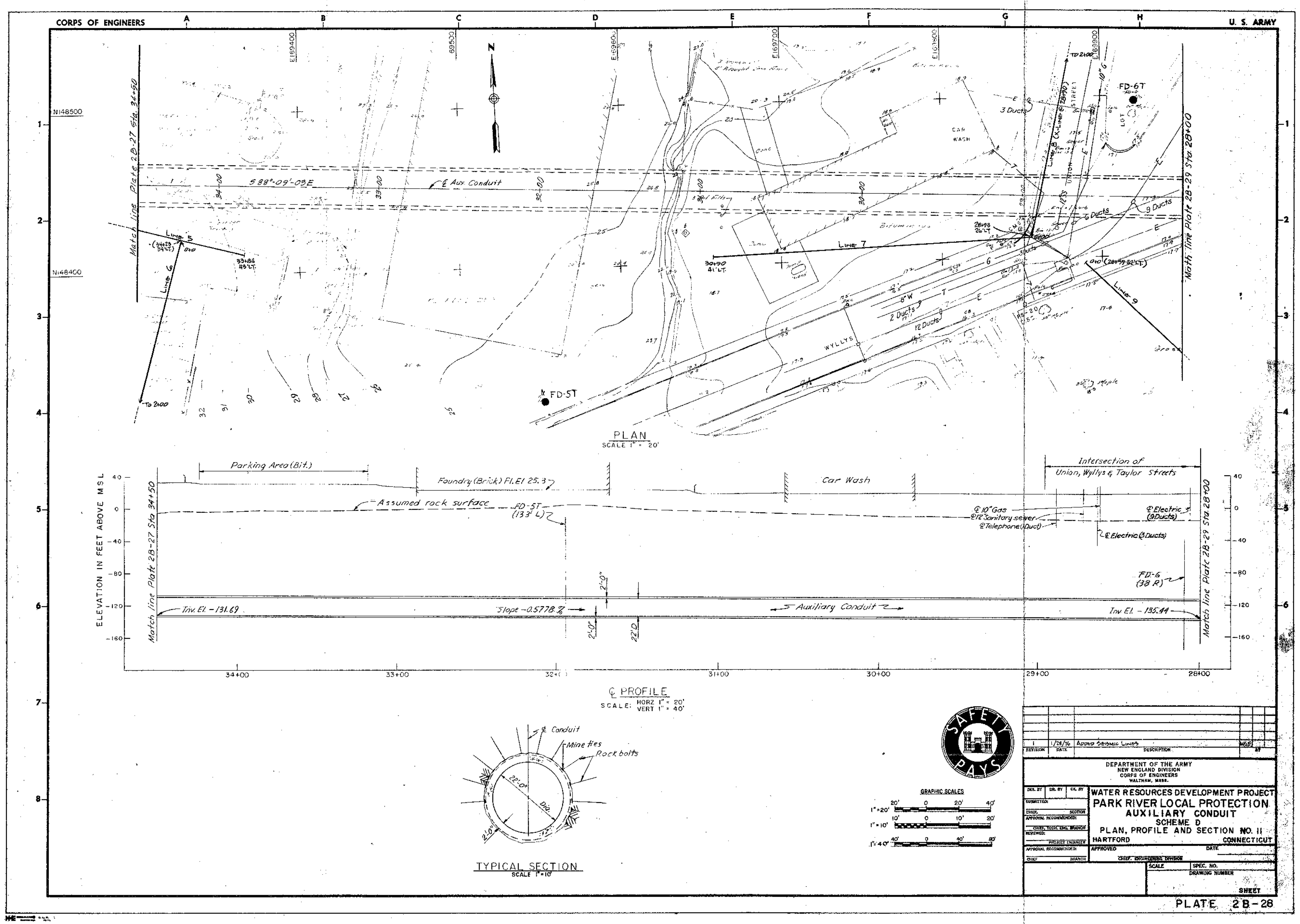
SHEET 4 OF 11



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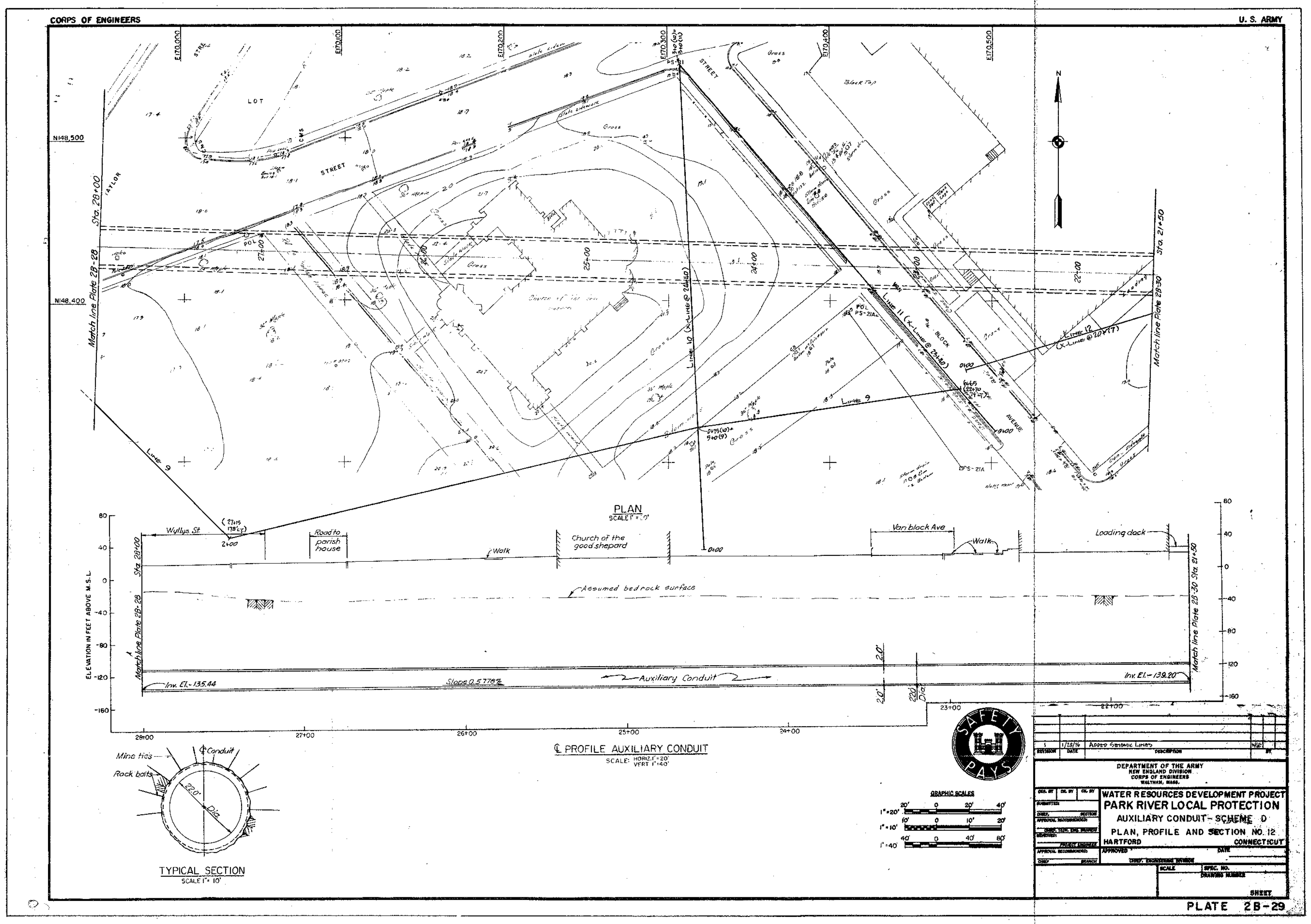
SHEET 5 OF 11



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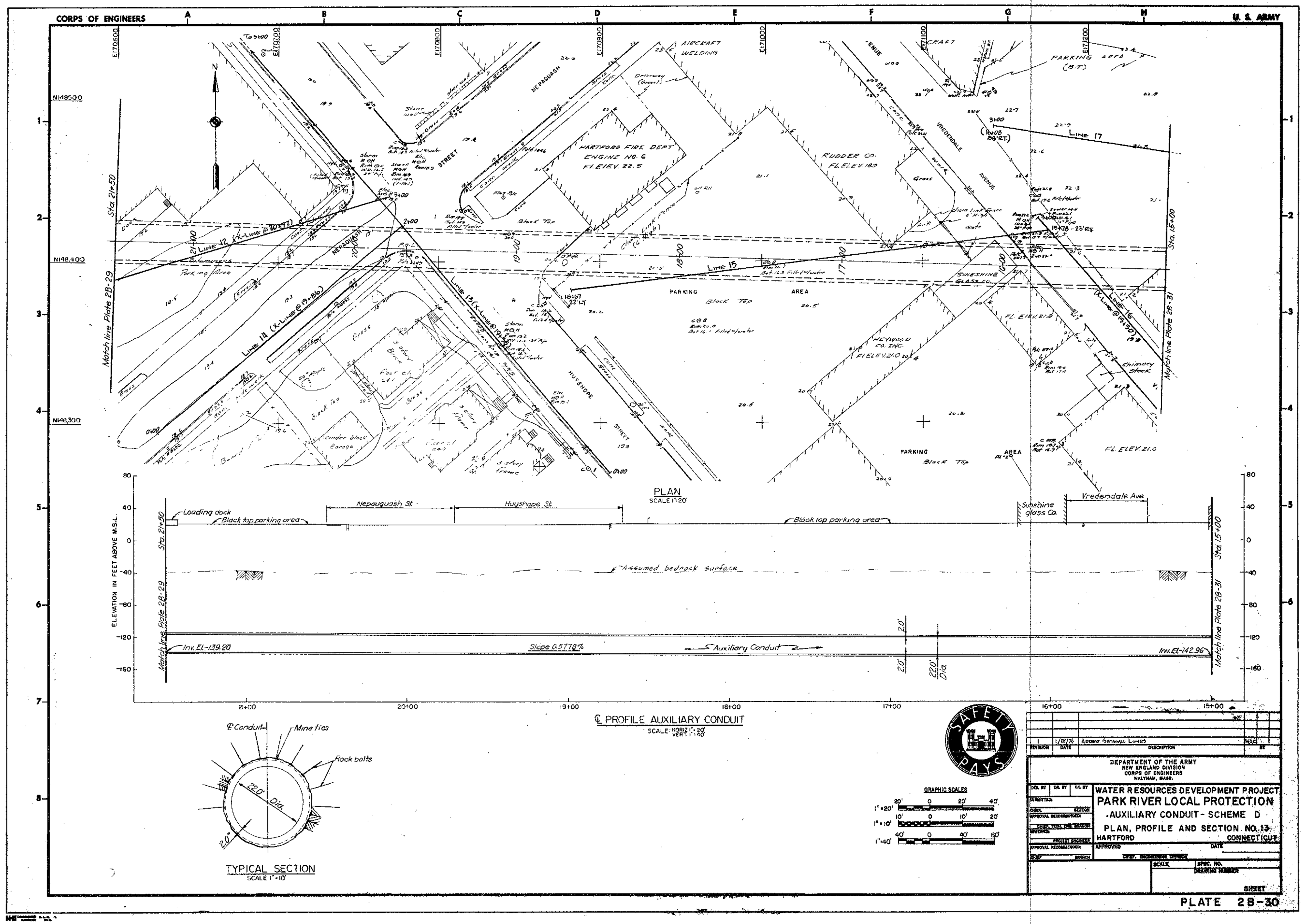
SHEET 6 OF 11



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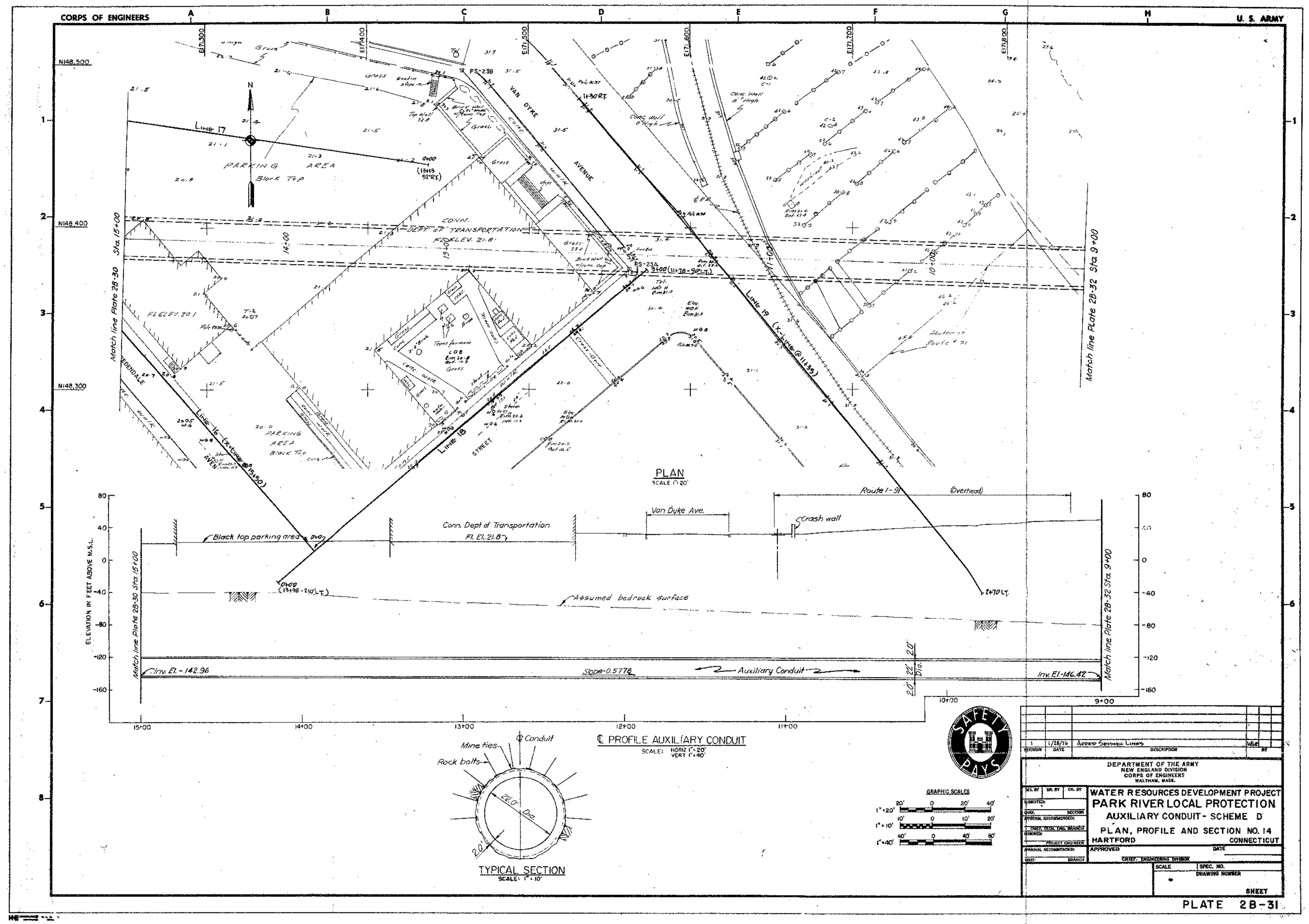

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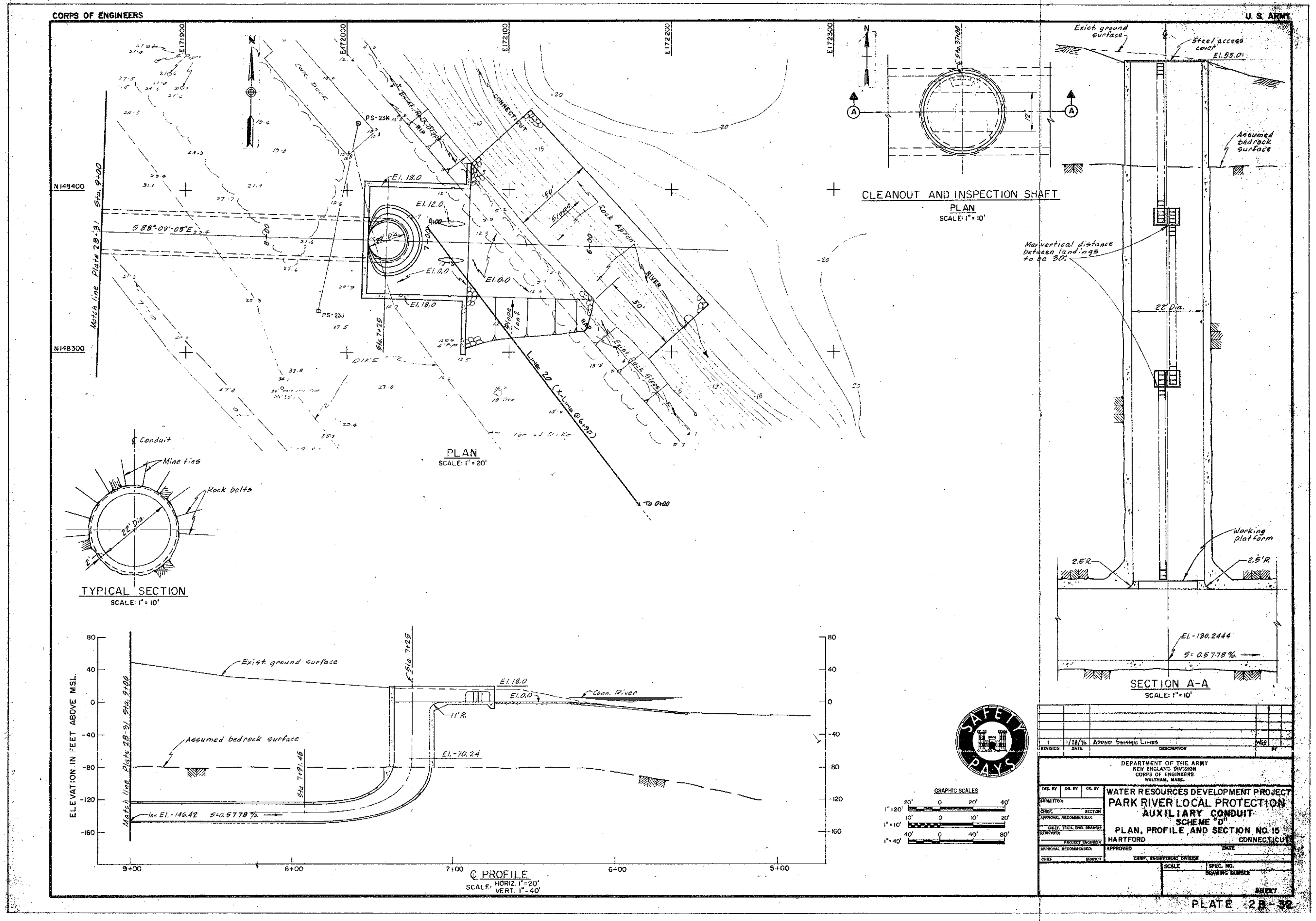

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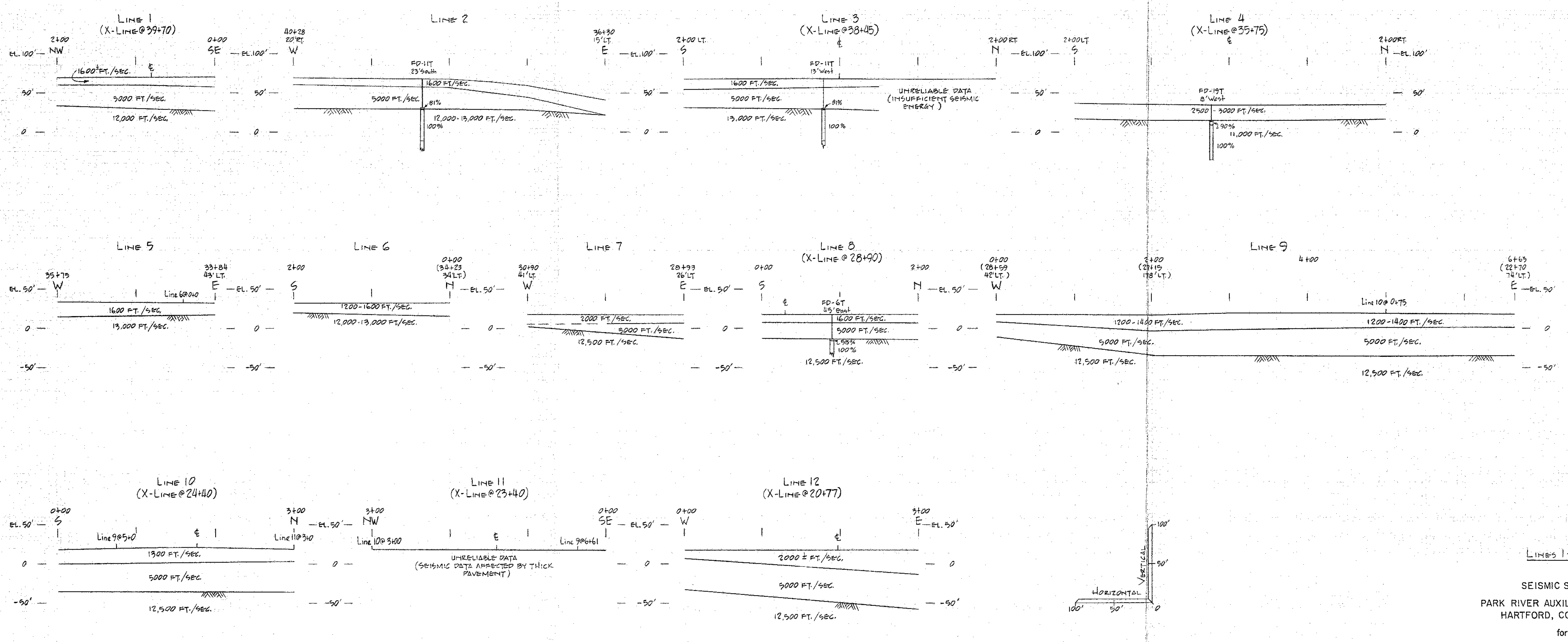

Lines 1 thru 12

SEISMIC SURVEY

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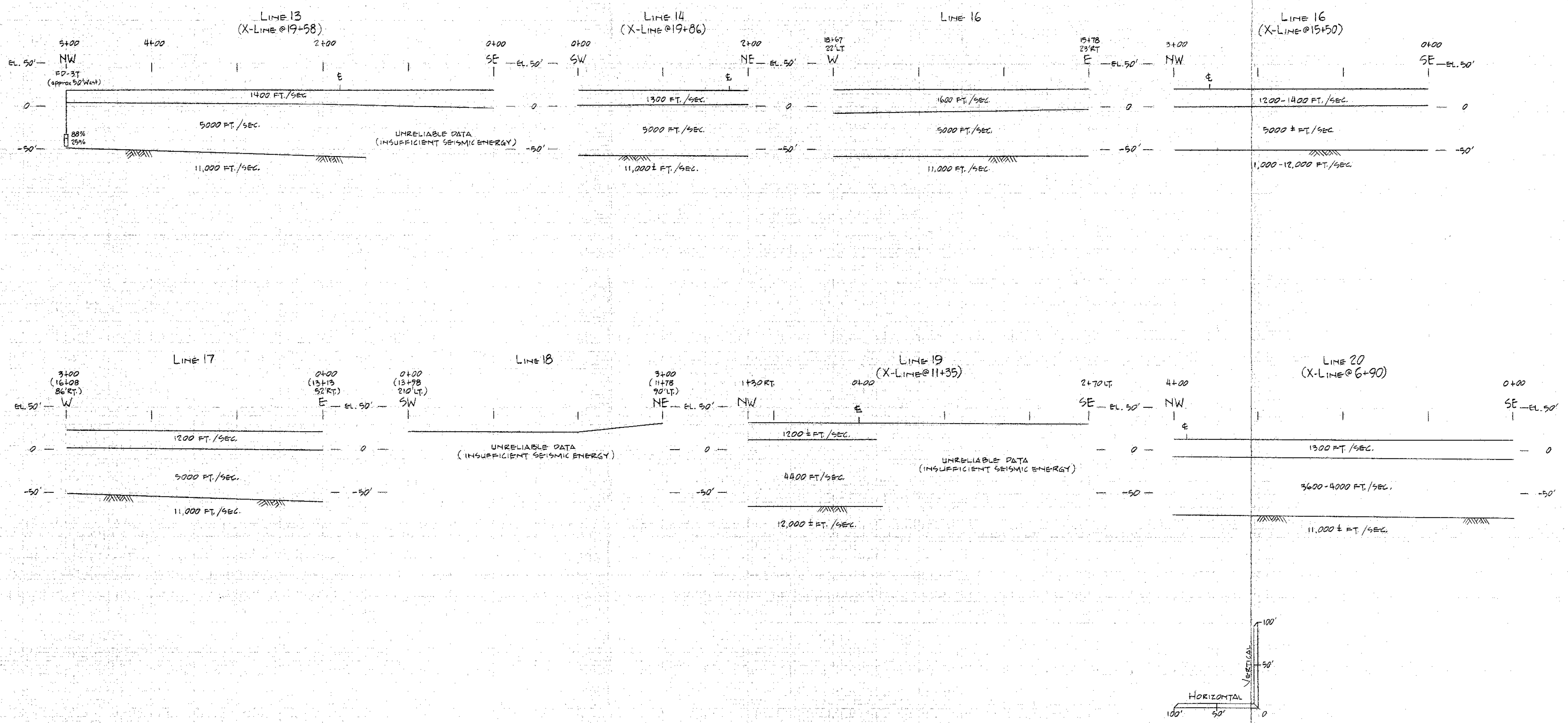
SHEET 10 OF 11



Lines 13 thru 20

SEISMIC SURVEY

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SHEET 11 OF 11

APPENDIX A

APPENDIX A

METHOD OF INVESTIGATION

General Considerations

The twelve-point seismic refraction method with the continuous profiling technique, developed for engineering investigations, was used.

The seismic refraction method is an indirect means of determining the depths to hard bedrock and the thicknesses of major seismic discontinuities overlying the high-velocity rock.

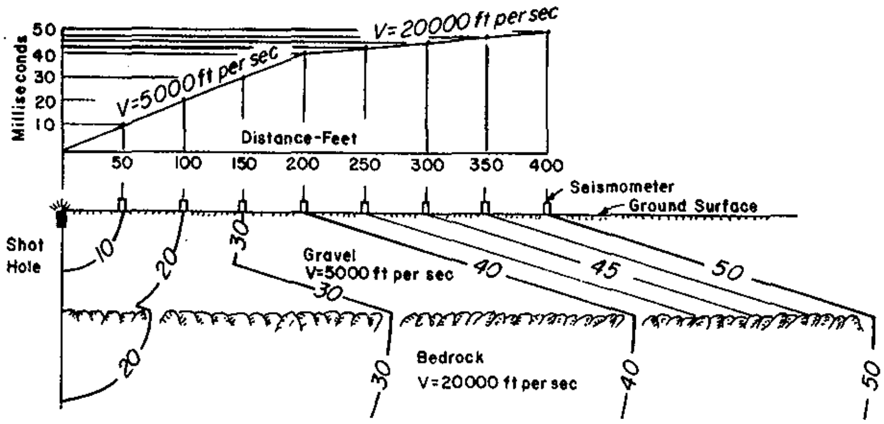
Interpretations are based on the measurement of the time required for elastic waves, generated at a point source, to travel to a series of vibration-sensitive devices (geophones or seismometers). These geophones are spaced at known intervals along a straight line on the ground surface. This instrument array with end shots is called a seismic spread.

The seismic wave used in a seismic refraction survey for depth calculations and material identifications is called a "P" (compressional) wave. This wave is transmitted through earth materials as a series of compressions and rarefactions. As a "P" wavefront passes a point in the earth, the point moves to and fro in the direction of wave propagation, giving rise to its alternate designation of a "longitudinal" wave. The "P" wave is transmitted to subsurface strata, and is refracted back through the uppermost layers to the detectors on the ground surface. If one makes a time-distance plot for each detector, a computation of the seismic velocity and the depths to the various materials is possible. A wavefront diagram and corresponding time-distance plot is shown for a simple two-layer case on Page A3 (Diagram A).

Continuous profiling is accomplished by having an end shot point of one spread coincident with an end shot point of the succeeding spread. The length of each spread is determined by the required depth of penetration. The deeper the required penetration, the longer the spread must be. All spreads used in this study were 200, 300, or 400 feet in length, with corresponding geophone intervals as indicated on the diagram on Page A3 (Diagram B).

<u>Field Procedure for Data Acquisition</u>

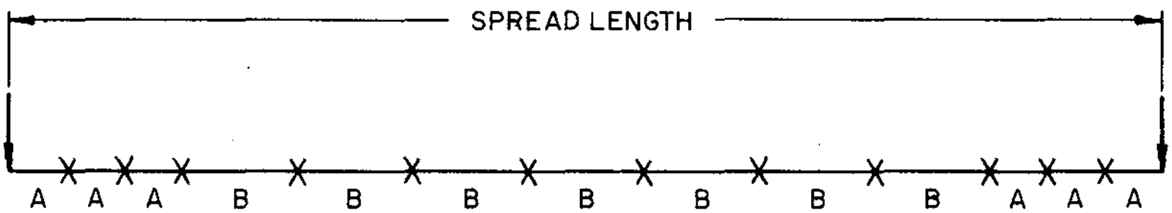
Seismic cables fabricated with shot point and geophone location markings were laid out along the lines of investigation. Geophones which have been fitted with a spiked or tripod base, so as to provide good ground contact, were



Plot of Wave Front Advance in Two Layered Problem

Linehan, Daniel, Seismology Applied to Shallow Zone Research, Symposium on Surface and Subsurface Reconnaissance, Special Technical Publication No. 122, American Society for Testing Materials, 1951.

Diagram A



SPREAD LENGTH	GEOPHONE SPACING A	B
200	10	20
300	15	30
400	20	40

LEGEND

X = GEOPHONE LOCATION

↓ = SHOT LOCATION

Geophone Interval-Spread Length Relationship

Diagram B

emplaced at their measured locations. Seismic energy was generated with the weight drop throughout most of the survey and with small buried charges of explosives adjacent to the Connecticut River. Shotholes were prepared with a driven rod (not excavated) so as to insure good ground coupling.

Seismograms were obtained using a portable, twelve-channel seismograph system which amplifies and filters the seismic signal, detected by the individual geophones, and provides a photographic recording for each of the twelve channels. Timing lines are provided across the entire recording at two-millisecond intervals allowing direct reading to one millisecond. This system contains a firing circuit which causes a time break to be displayed on the seismic record. Arrival times between the shot and each geophone location are measured in reference to the time break. The seismograph is equipped so that the background noise level can be observed (monitored) for all geophones simultaneously, enabling the instrument operator to determine if the background noise is sufficiently quiet to minimize trace interference.